

TITLE: STUDY OF ACTIVATION OF COAL CHAR

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DOE GRANT NO.: DE-FG2699-FT40582

**PERIOD OF
PERFORMANCE:** July, 1999-June, 2002 **Date:** April, 2001

ABSTRACT

OBJECTIVE

Coal is an important feedstock for the preparation of certain kinds of activated carbon products, and there continues to be significant interest in developing other high value added products from coals. One of the main difficulties associated with the development of products is the highly empirical nature of the process. Attempts to introduce a new feedstock or new activation condition require a great deal of experimental investigation, since no reliable predictive models of the porosity development process are available. This is attributable to the complexity of the processes that are involved. There are many factors that determine the characteristics of activated carbons obtained from any starting material. One of the factors is the chemical nature of the starting material. Another is the pyrolysis conditions. Also important are the nature of the activation process as well as whether the material contains any catalytic agents.

There are two main characteristics that determine the properties of an activated carbon, once it is prepared- the nature of the porosity, and the chemical nature of the surfaces of the carbon. This project is mainly concerned with the first of these, as the ability to manipulate the second is available, once a suitable carbon structure has been prepared. The problem of porosity development during combustion, gasification, or activation is of considerable fundamental interest, beyond the general application area of main interest in this project. A great many studies of porosity development have been performed by researchers in the gasification and combustion fields. Several models have been proposed, but none has been rigorously tested over a wide range of materials and activation conditions.

The present program initially involves a heavily experimental component, and will use these results to guide modeling efforts. The main characterization methods include gas adsorption techniques, and the activation is being conducted in a wide range of gaseous environments.

ACCOMPLISHMENTS TO DATE

Since one of the main factors determining the nature of porosity development is the conditions during pyrolysis, samples prepared under widely varying conditions are being examined. One set of samples has been prepared under the slow heating conditions characteristic of laboratory furnaces. The other set has been prepared under the intense, high heating rate conditions characteristic of utility boilers. The development of porosity in these two types of samples has been compared, under intrinsic air oxidation conditions. These results have clearly shown that both softening and non-softening coal chars develop porosity which is relatively insensitive to the char preparation (pyrolysis) conditions. The nature of the char, and the degree to which porosity can be opened, depends mainly upon the nature of the starting material. This comes as little surprise, as it has been known for some time in the activated carbon industry that the choice of feedstock is essential to preparing the desired carbon. What was surprising was the degree of insensitivity to other factors.

The choice of activating agent and conditions showed a significant effect on porosity. This, too, is not surprising as a general conclusion. What was surprising was the fact that different activating agents gave different trends with different carbons. This is reflecting a degree of sensitivity to the starting char chemical structure, which could not readily be predicted from the published literature. It was also clear that the choice of adsorptive gas used for examining the porosity can significantly affect the impression of porosity development during the processes. The use of carbon dioxide appears, as a general rule, to be problematic, as compared to the use of nitrogen, in spite of the well-known issues regarding activated diffusion barriers to the latter.

PLANS FOR THE UPCOMING YEAR

The project is in mid-phase, as a delayed start was required because the grant announcement date and student recruitment date did not coincide well. The experimental work is now focusing on characterizing a broader range of samples, so that a more general picture of the influence of starting material can be developed. The influence of mineral matter is being explored. Also, the use of steam as an activating agent is receiving more attention, due to the industrial importance of this agent. The development of porosity at high partial pressures of activating agents will also be explored.

ARTICLES AND PRESENTATIONS, AND STUDENTS RECEIVING SUPPORT

“Development of Porosity During Coal Char Combustion and Gasification”, paper prepared for presentation at the 2001 International Conference on Coal Science. Indrek Aarna, Indrek Külaots, Melissa Callejo, David Deutsch, and Eric M. Suuberg.

Students supported on this grant: Allan Vragar (graduate student), Melissa Callejo (undergraduate student), David Deutsch (undergraduate student), and Indrek Külaots (partial support, graduate student).